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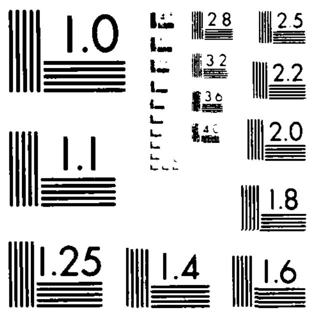

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Naval Ocean Research and Development Activity
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Mechanical Details of a Modified Hamilton Frame Velocimeter

NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY
NORDA
1976

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Seafloor Geosciences Division

September 1983

NOTICE

The mention of commercial products or use of company names does not in any way constitute an endorsement of the product. These items are normally available from a variety of distributors. They are cited in this report primarily to differentiate between items fabricated at NORDA, and those that were purchased. They have, however, been found to be completely satisfactory for the purpose for which they are used in the Modified Hamilton Frame.

ABSTRACT

The Hamilton Frame is a velocimeter used aboard the Deep Sea Drilling Project (DSDP) drill ship GLOMAR CHALLENGER, and at the Naval Ocean Systems Center (NOSC), to measure the compressional wave velocity within sediment and rock samples. The design of this instrument has been modified at the Naval Ocean Research and Development Activity (NORDA) to permit both compressional and shear wave velocity measurements. The modified device also monitors the transducer induced stress on the sample material, a factor that is critical to some measurements. This report documents, with mechanical drawings and photographs, the mechanical details of the Modified Hamilton Frame in use at NORDA.

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CONTENTS

MECHANICAL DETAILS OF A MODIFIED HAMILTON FRAME VELOCIMETER

INTRODUCTION

The "Hamilton Frame" is a portable instrument capable of measuring compressional wave velocities in fluids, soft sediments, and rocks. These measurements are made using a pulsed source signal technique where time delays are measured on an oscilloscope, and transducer separations are measured with a dial micrometer. The device was first conceived by G. Shumway at what was then the U.S. Naval Electronics Laboratory (NEL), and first described in Shumway and Abernethy (1961). Modifications to the system (primarily newer electronics) are described in Abernethy (1965). This device has been in continuous use at NEL (now the Naval Ocean Systems Center, NOSC); where it has been used to obtain much of the submarine sediment compressional wave velocity data published by both G. Shumway and E. L. Hamilton.

Most soft sediment compressional wave velocity measurements are made through core liners using instruments based upon the design of Winokur and Chanesman (1966). Such an instrument was used by the Deep Sea Drilling Project (DSDP) aboard the drill ship GLOMAR CHALLENGER to measure compressional wave velocities in soft sediments on DSDP Legs 1 through 14. The desire to also measure the compressional wave velocity in rock cores led R. E. Boyce of the DSDP to duplicate the Shumway device. The instrument is referred to as the Hamilton Frame (Boyce, 1973), and is a duplication of the NOSC device. This terminology is now entrenched in the literature.

From Leg 15 to present, DSDP has used the Hamilton-Frame exclusively for on board measurements of compressional wave velocity in soft sediment and rock cores. A similar instrument also was needed for research programs at the Naval Ocean Research and Development Activity (NORDA). However, the only detailed documentation available for fabricating the device were the unpublished mechanical drawings and photographs made for building the GLOMAR CHALLENGER version (Boyce, 1970). To facilitate repair or the construction of additional instruments, a complete set of mechanical drawings and materials specification list for the NORDA model have been prepared. These are presented here in an attempt to simplify and standardize the system. NORDA programs require both compressional and shear wave velocity measurements. The mechanical frame was, therefore, modified from the GLOMAR CHALLENGER version to allow the use of NORDA designed interchangeable compressional and shear wave transducers. These transducers and associated electronics are significantly different from what is described in Abernethy (1965) and Boyce (1973). For this reason the NORDA version is called a Modified Hamilton Frame. Figure 1 depicts the assembled Modified Hamilton Frame without transducers.

MECHANICAL DRAWINGS AND PARTS LIST

This section provides the drawings and material specifications used to fabricate the Modified Hamilton Frame. Whenever possible, "off-the-shelf" items were used to minimize the fabrication time and cost. Table 1, which itemizes the materials used, is keyed to Figure 2 (a plan and top view of the device). Most of the items listed are readily available from a variety of distributors. Specialized items, such as bearings or retaining rings are specified by distributor and part number. However, equivalent items generally can be obtained from other vendors.

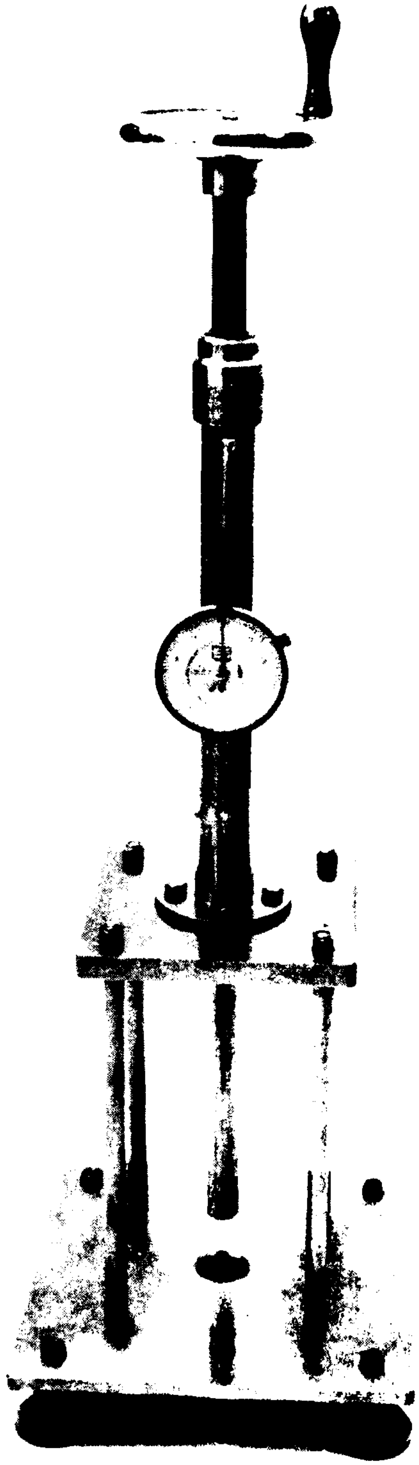

Figure 1. Modified Hamilton Frame Velocimeter

Table 1. Parts and specifications list for specific components of the Modified Hamilton Frame Velocimeter

ITEM NO.	NOMENCLATURE	QTY.
1.	Base Plate, SS (stainless steel), 12.00" x 12.00" x 0.50" thk.	1
2.	Leveler, McMaster Carr Supply Co., cat. no. 6014K12	4
3A.	Support spacer, SS tubing, 5/8" O.D., 0.065" wall, 12.00" long	4
3B.	Support spacer, SS tubing, 5.8" O.D., 0.065" wall, 6.00" long	4
4A.	Threaded rod, SS, 3/8"-16 UNC, 14.75" long	4
4B.	Threaded rod, SS, 3/8"-16UNC, 8.75" long	4
5.	Self-locking hex nut, SS 3/8"-16 UNC	8
6.	Flat washer, SS, 3/8" I.D.	12
7.	Top plate, SS, 8.00" x 8.00" x 0.075" thk.	1
8.	Cylinder flange, SS, 4.00" Dia., 1.06" thk.	1
9.	Flange bolt, SS, hex head cap screw, 3/8"-16 UNC, 1" long	4
10.	Transducer shaft, 303 SS, Wingred M. Berg Co. stock no. S1-60, 1.0000" Dia., 14.86" long	1
11.	Cylinder, 304 SS seamless tubing, 1 1/2" O.C., 0.188" wall thickness, 15.65" long	1
12.	Adjustment screw guide, SS, 2.00" Dia., 2.37" long	1
13.	Adjustment screw, SS, 1"-14 UNF, 18.75" long	1
14.	Handwheel, McMaster Carr Supply Co., cat. no. 6022K38	1
15.	Handwheel nut, SS, self-locking hex nut, 1/2"-13 UNC	1
16.	Handwheel flat washer, SS, 1/2: I.D.	1
17.	Dial indicator, Soiltest, Inc., cat. no. 1C-11	1
18.	Dial indicator support rod, SS, 0.3745" Dia. ground shafting, 8.00" long, Winfred M. Berg Co., stock no. S1-75	1
19.	Dial indicator support clamp, SS, 0.50" thickness x 0.69" wide x 1.75" long	1
20.	Thumb screw, SS, Special 6-32 UNC 0.05" long	2
21.	Ball bearing, Nice Ball Bearing Co., stock no. 1602-DC single row radial ball bearing, double sealed, 1/4" bore, 11/16" O.D., 5/16" W	1
22.	Internal retaining ring, SS, Waldes Truarc, cat. no. 5100-25	1
23.	Internal retaining ring, SS, Waldes Truarc, cat. no. N50000-68	1
24.	Shaft bushing, bronze 1.124" O.D., 1.0005" I.D., 2" long	1
25.	Cylinder bushing, bronze, 1.127" O.D., 1.0010" I.D., 1" long	1
26.	Dial indicator adapter clamp, SS, 0.50" thickness x 0.69" wide x 1.03" long	1
27.	Dial indicator clamp screw, SS, 1/4-28 UNF, 0.75" long, hex head machine screw	1
28.	Dial indicator clamp nut, SS, 1/4-28 UNF hex nut	1

NOTES

1. The distance between base plate and top plate is adjustable. Use support spacer 3A and threaded rod 4A for 12.00" separation; use support spacer 3B and threaded rod 4B for 6.00" separation.

2. The cylinder bushing should be pressed into cylinder before the bushing is bored.

3. Remove or deburr all sharp edges.

4. Unless otherwise specified all tolerances are as follows:

   .xx = $\pm$0.01,   .xxx = $\pm$0.002,   Angularity = $\pm$2°.

5. Lubrication requirements: lubricate adjustment screw with a good quality anti-seize lubricating compound. Use a good quality dry film lubricant on the transducer shaft and bushings.

Figures 2 through 12 are a series of mechanical drawings that provide the detail necessary to machine and assemble the frame. These detailed drawings are also keyed to the item numbers given in Figure 2.

TRANSDUCER ARRANGEMENT

The principal difference between the Hamilton Frame and the Modified Hamilton Frame is the ease with which the transducers can be interchanged on the latter. This modification facilitates compressional and shear wave velocity measurements. All transducers for the Modified Hamilton Frame are constructed in an external housing (Fig. 13) consisting of a 2" length of nominal 1.5" O.D. acrylic tubing (0.115" wall thickness). This report deals only with the mechanical detail of the Modified Hamilton Frame, including how the transducers are mounted. The transducer design and associated electronics will be documented elsewhere.

The transmitter housing (Fig. 13) has an acrylic collar attached near its active end, and an octagonal sheet of silicone elastomer is cast around the collar. This arrangement allows the transmitter to slip easily into the 1.53" hole centered in the frame's base plate (Fig. 13) and rest firmly on its collar. The transmitter extends below the frame's base plate, but clears the table upon which it rests as a result of the shock absorbing, adjustable height legs. This clearance also provides room for the signal leads which extend from the base of the transducer. The upper surface of the elastomer sheet (Fig. 13) is flush with the transmitter's active face, where together they form a smooth and easily cleaned surface upon which to place samples for measurement.

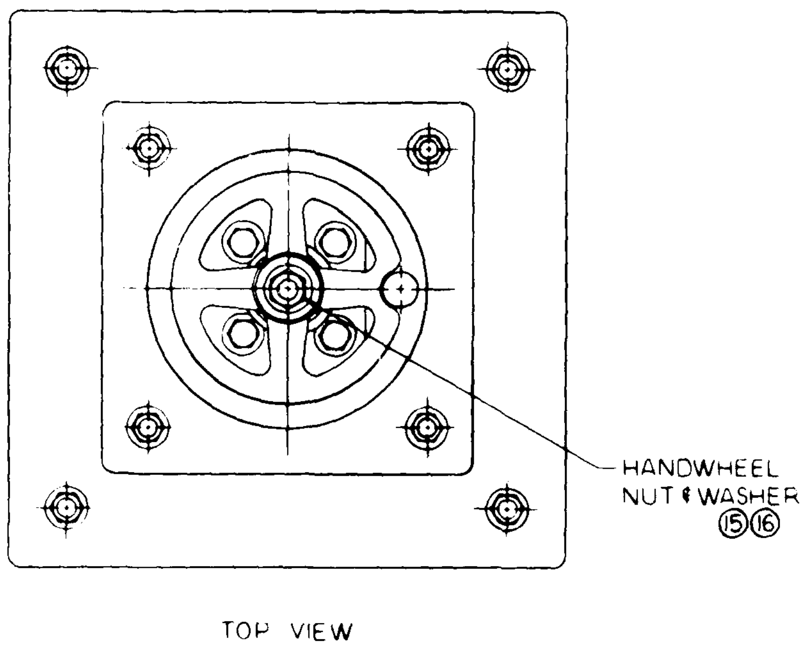

Figure 2. Top and plan view of Modified Hamilton Frame

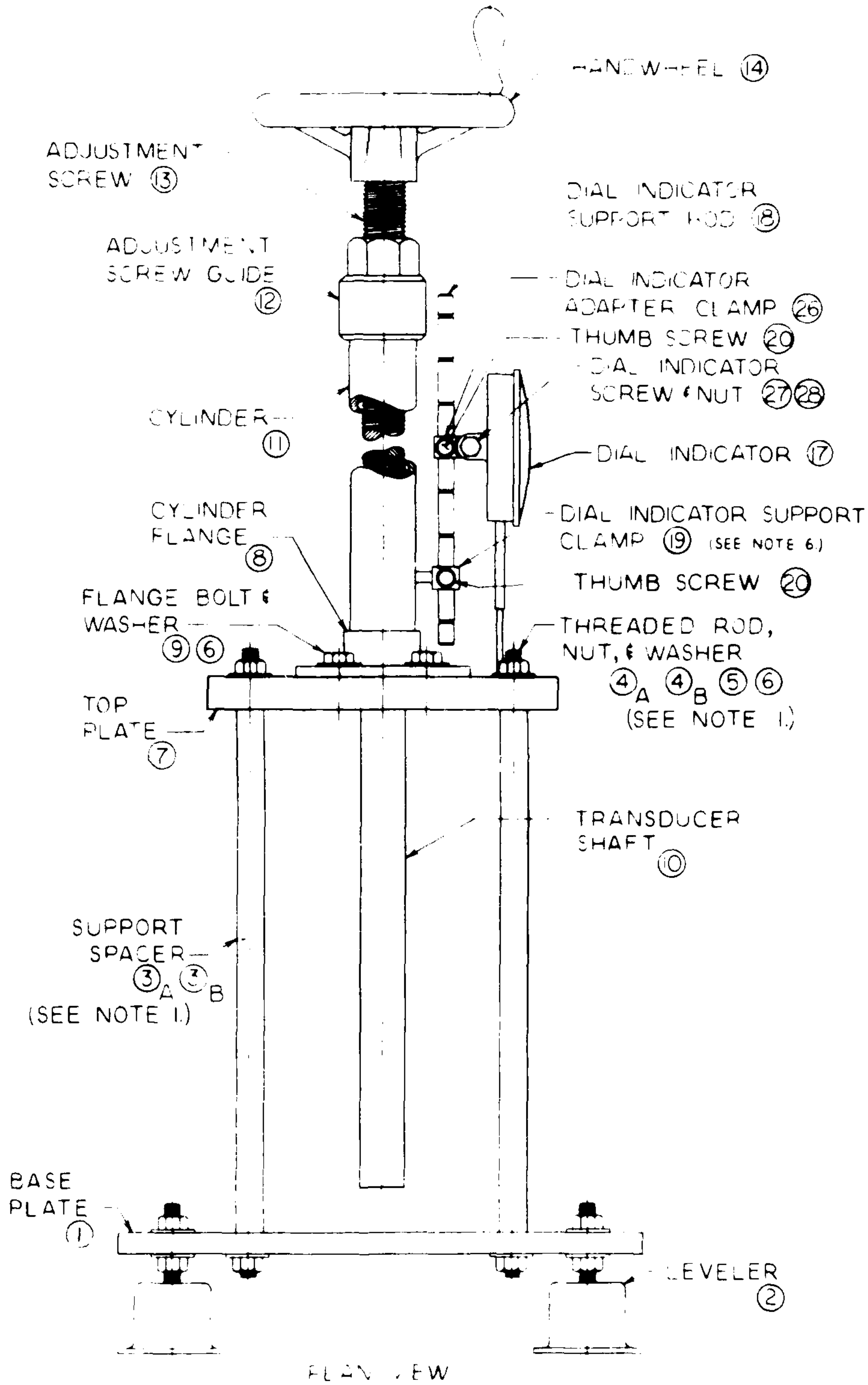

Figure 2 (continued).

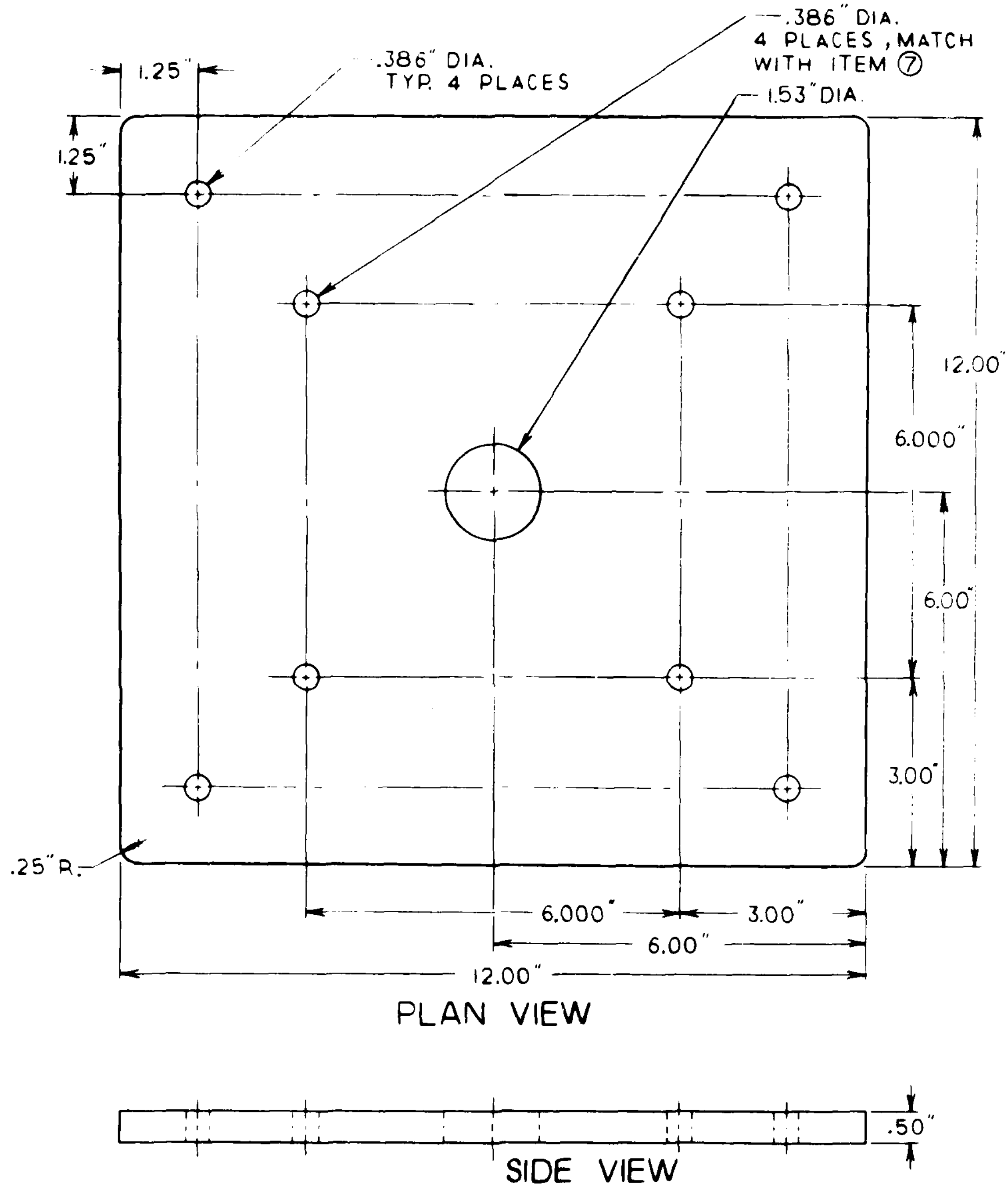

Figure 3. Base plate

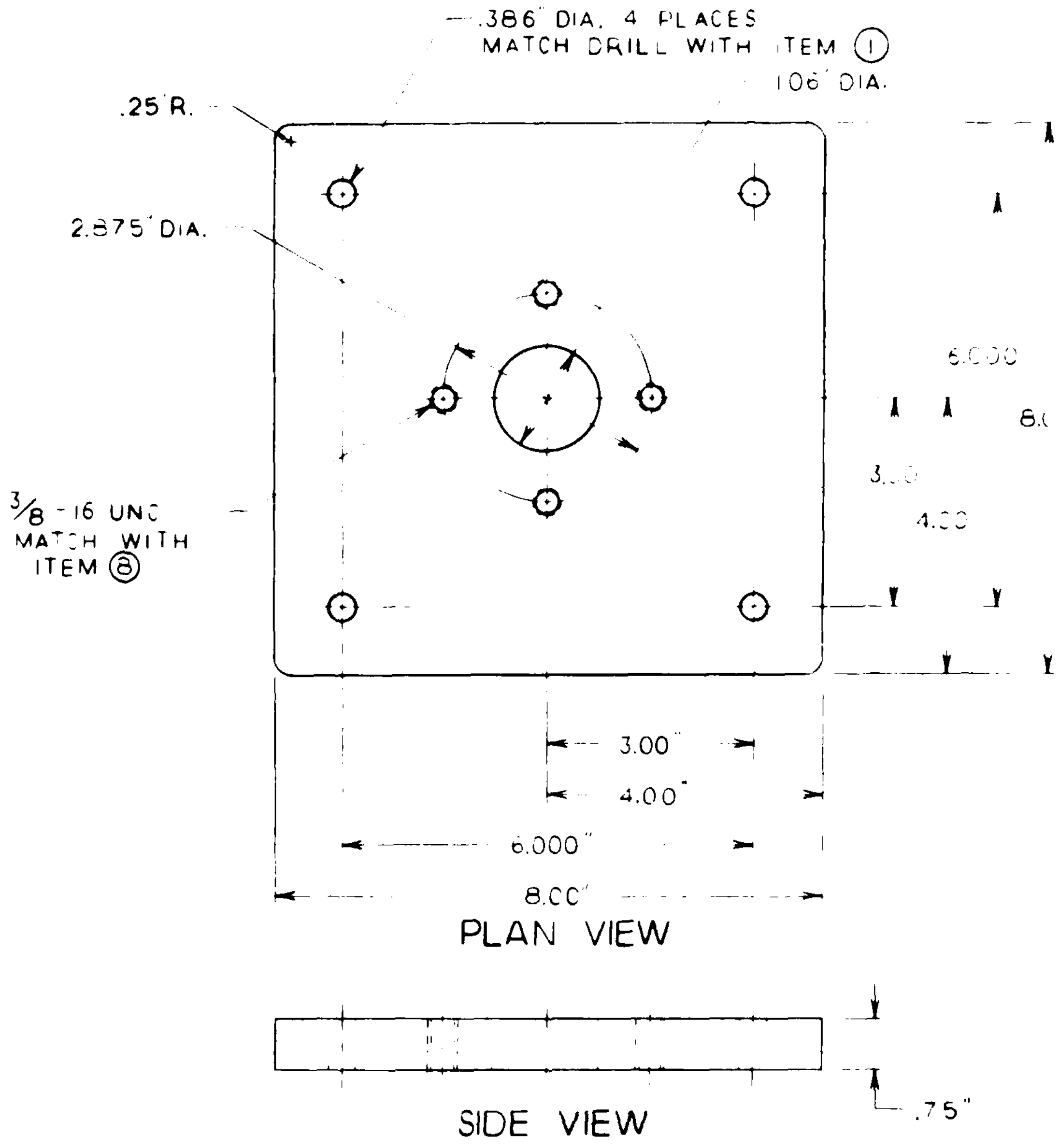

Figure 4. Top plate

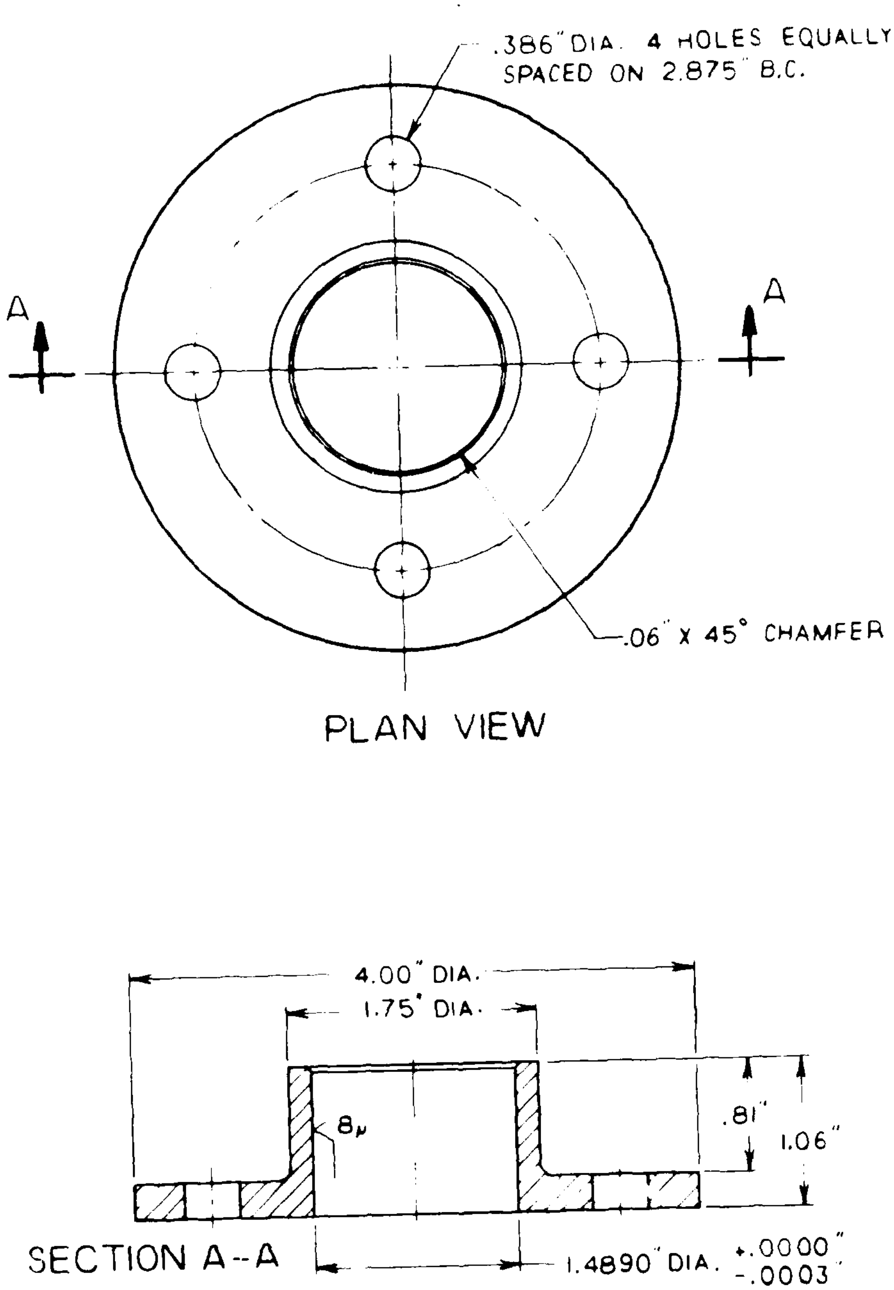

Figure 5. Cylinder flange

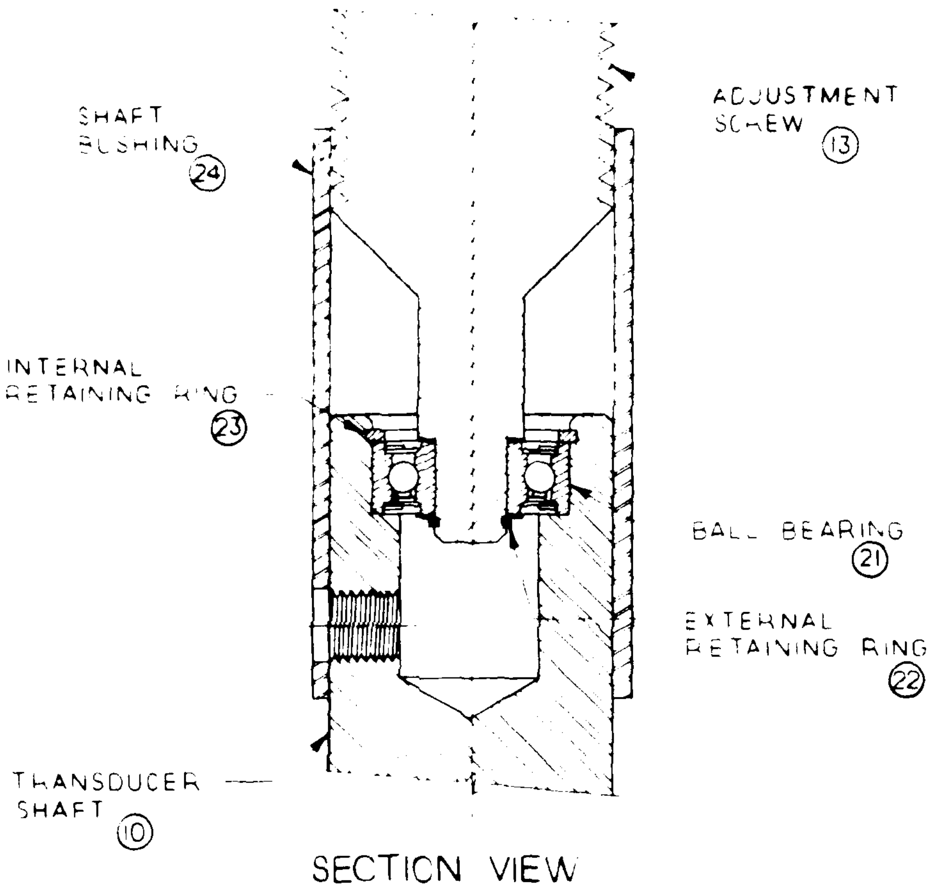

Figure 6. Transducer shaft – adjustment screw interface

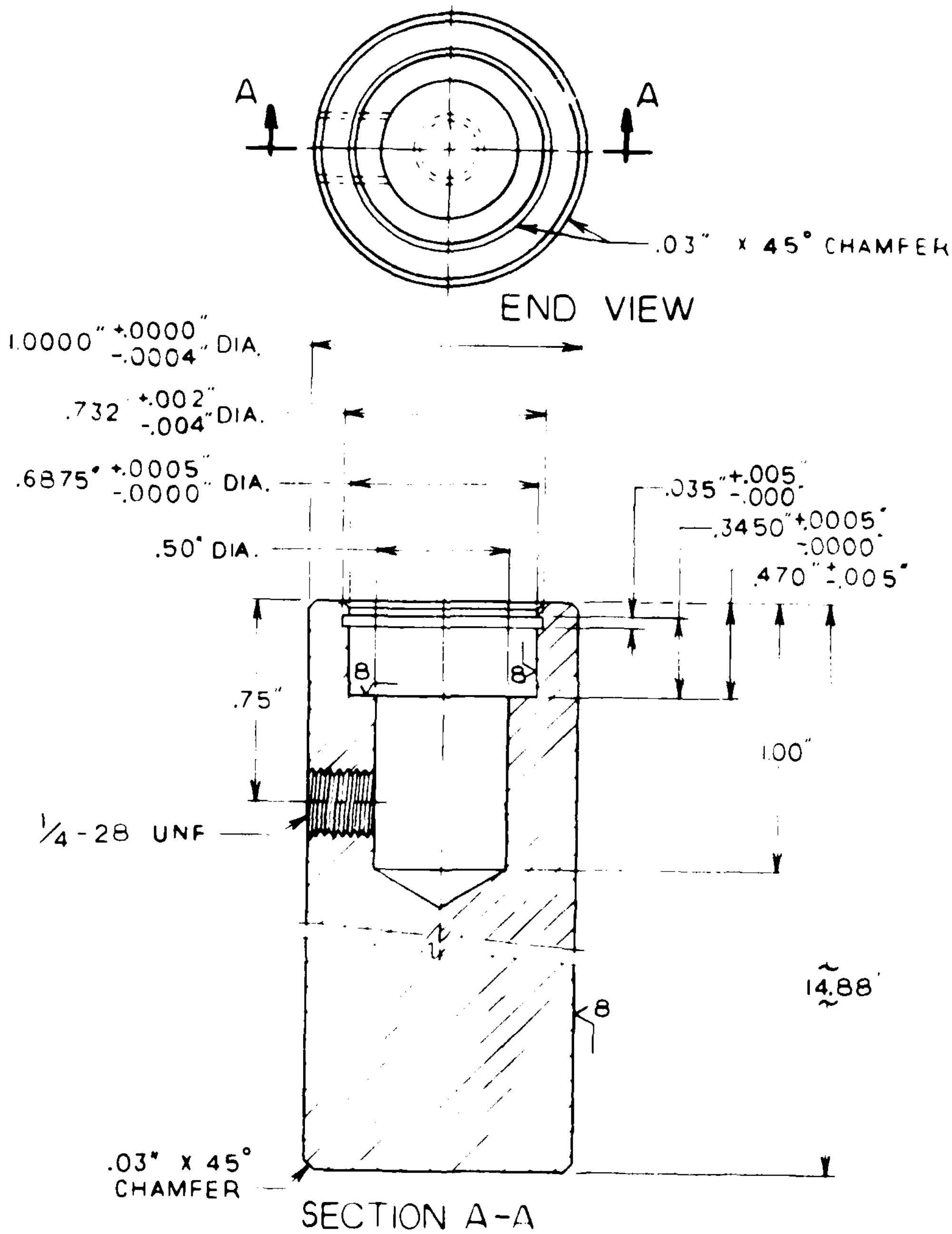

Figure 7. Transducer shaft

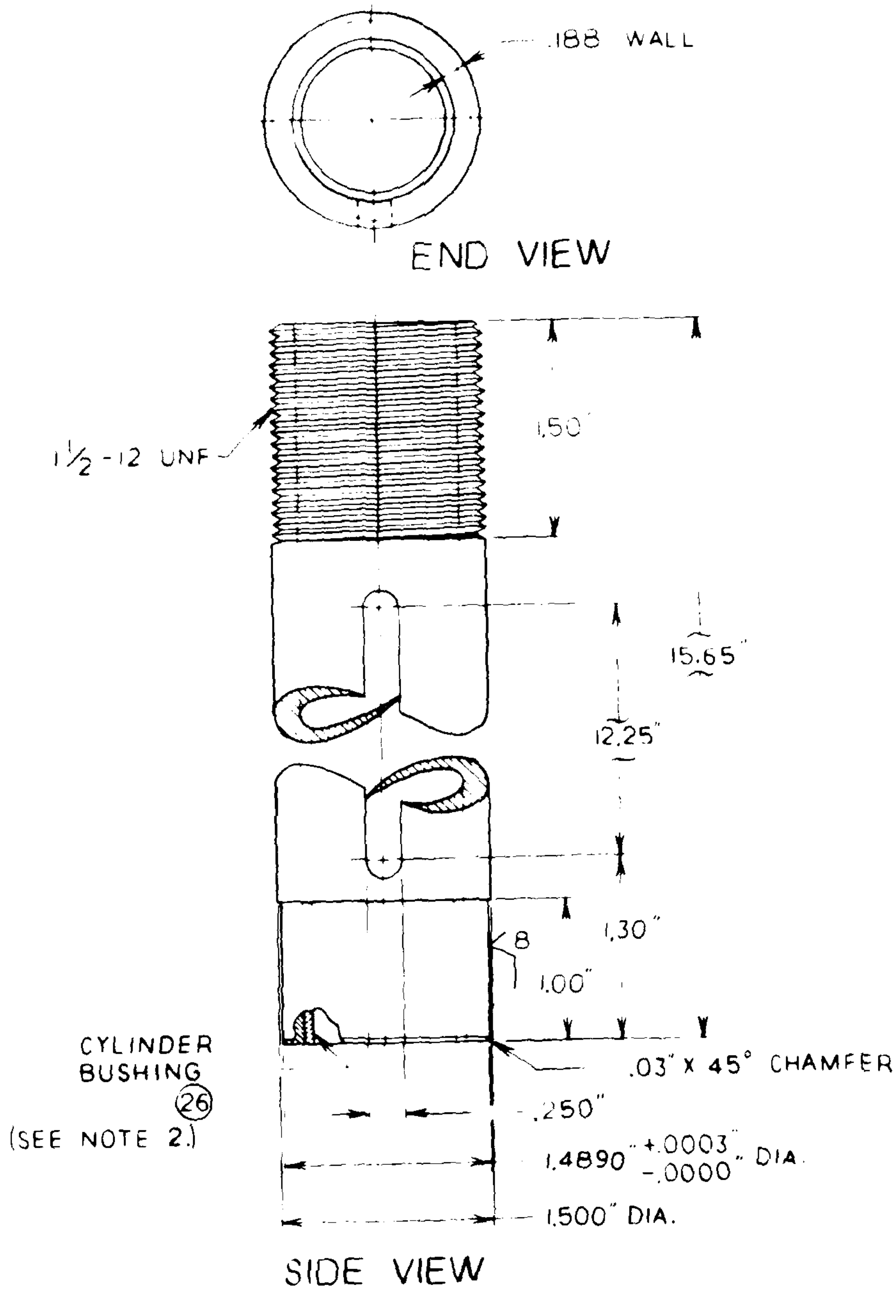

Figure 8. Cylinder

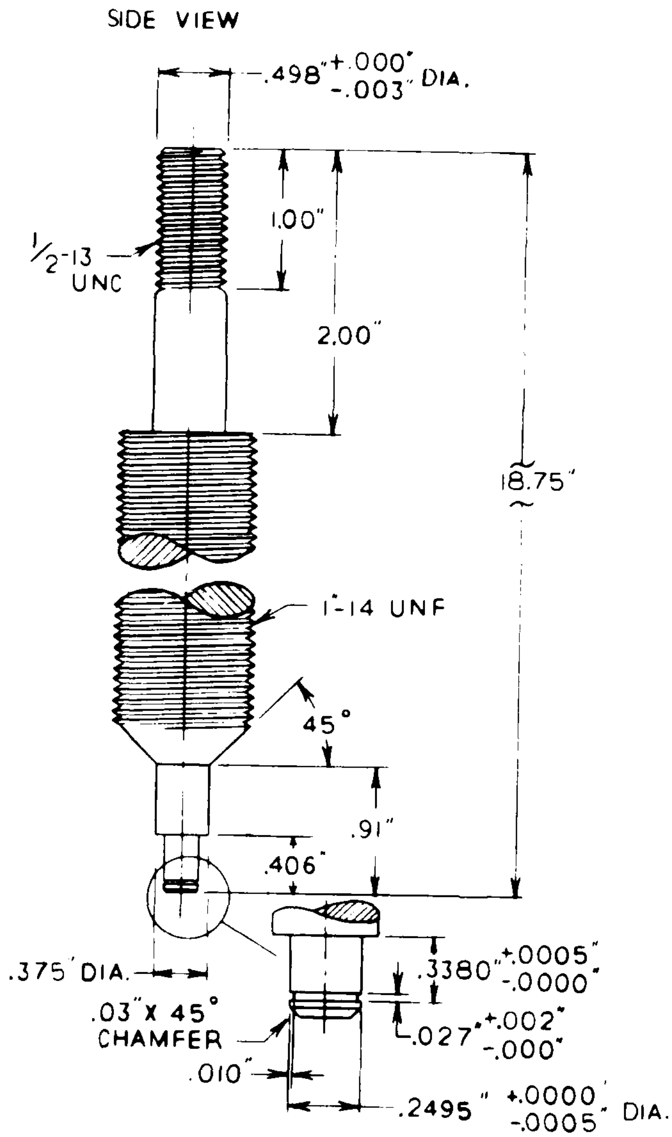

Figure 9. Adjustment screw

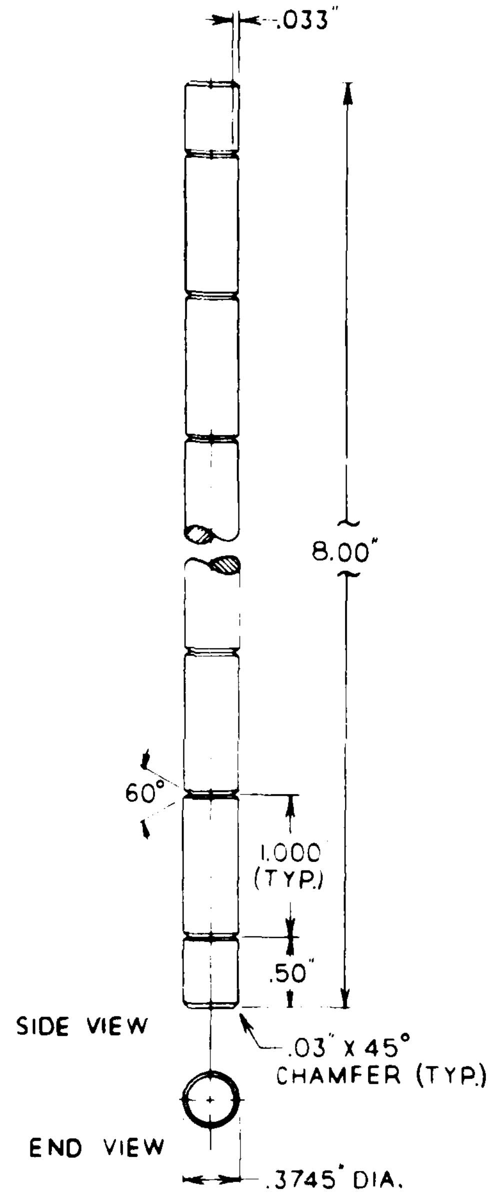

Figure 10. Dial indicator support rod

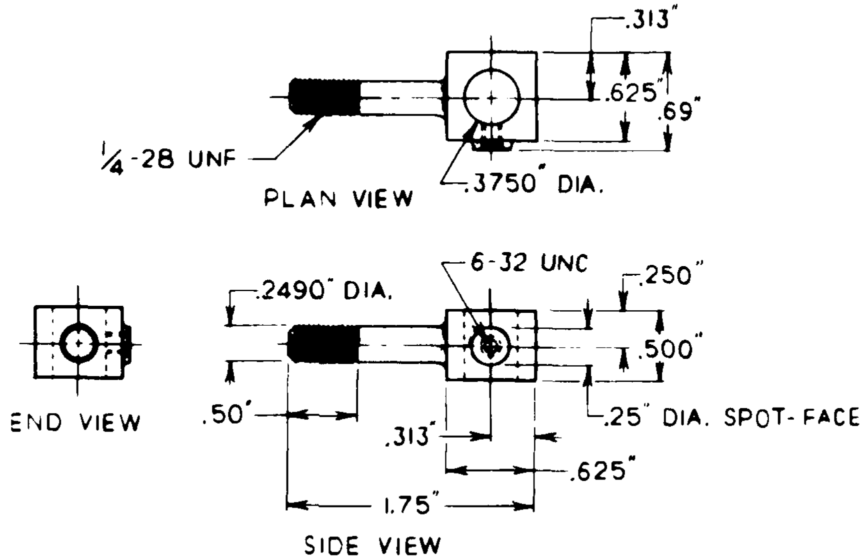

Figure 11. Dial indicator support clamp

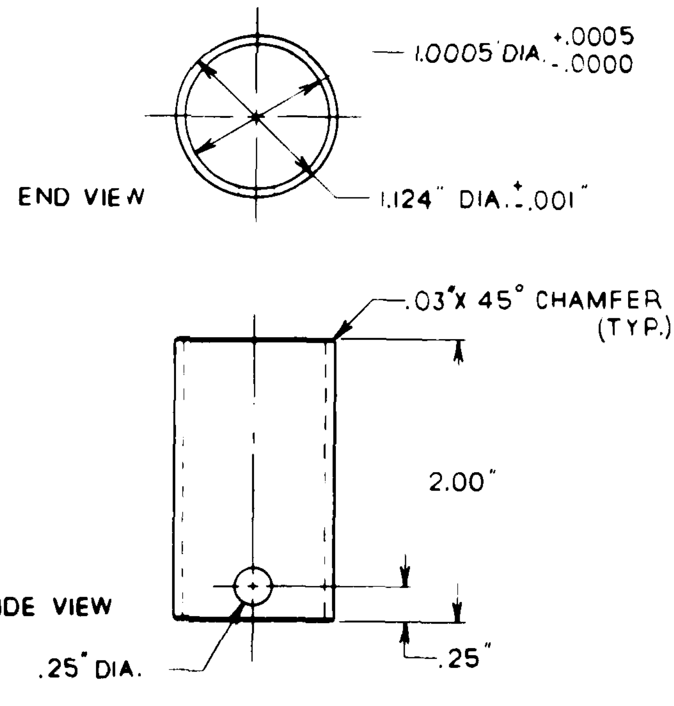

Figure 12. Shaft bushing

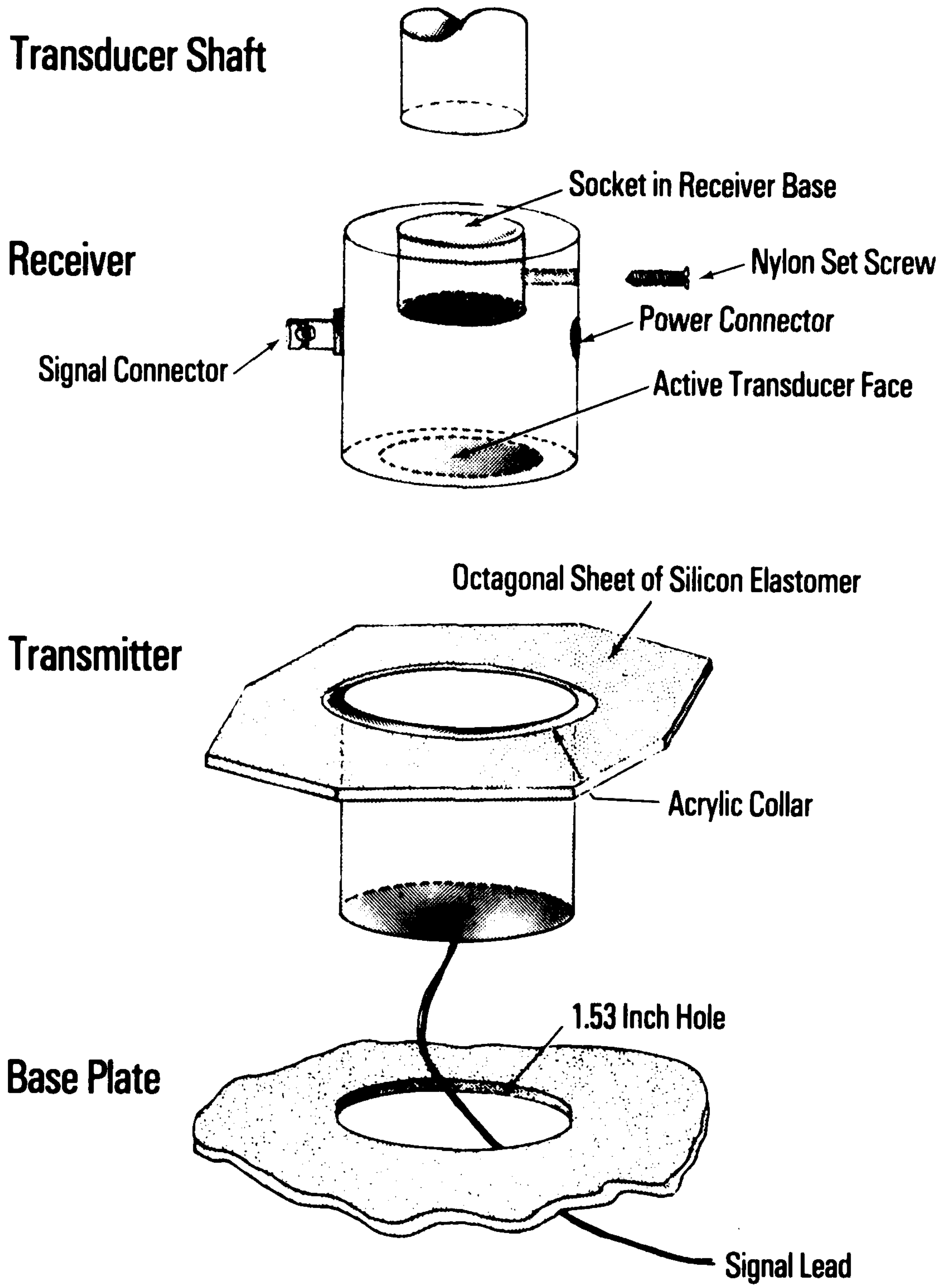

Figure 13. Transmit and receive transducer configuration

The base of the receiving transducer (Fig. 13) is filled with cast acrylic, that contains a cylindrically shaped cavity. This cavity allows the receiver to be slipped onto the end of the frame's transducer shaft (Item 10, Fig. 2) where it is held in place by a nylon-tipped set screw (Fig. 13). Electrical connectors on the receiver allow attachment of the signal lead, and, if required, the battery leads for the receiver's preamplifier.

In many instances, especially when making shear wave velocity measurements of soft low permeability sediments, it is necessary to monitor the stress applied to the sample by the transducer. This is because of pore pressure effects resulting from the stress. The transmitter is fixed in the base and supports the sample, while the receiver is brought into contact with the sample by movement of a threaded rod connected to a handwheel (Item 14, Fig. 2). The operator, however, cannot accurately judge the amount of stress being applied to the sample by the receiving transducer. If stress loading is critical to the measurement, a load cell can be mounted between the receiver and the transducer shaft. The device used at NORDA is a Schaevitz Engineering Co. Mod. FTD-1T linear variable differential transducer (LVDT) type load cell. This device is powered by a +15 and -15 volt power supply; operates in both tensional and compressional modes; and is available in 1, 2, 5, 10, 20, or 50 pound full scale load models. These load cells have an output voltage ranging from -5 to +5 volts full scale, which is normally recorded on a strip chart recorder.

Both ends of the load cell come with a 1/2" length of 1 1/4"-12 UNF threads. Two adaptors must, therefore, be made to install the load cell. One is a 1.5" diameter 1.25" long aluminum cylinder with a threaded hole on one end to fit the load cell, and in the other end is a 1.0005+0.0005" diameter bored hole (with a set screw) to fasten the adapter to the transducer shaft. The lower adapter is also a 1.5" diameter aluminum cylinder with a threaded hole on one end, with the other end turned down to a 1.0000±0.0005" diameter shaft that fits into the base of a receiving transducer. Figure 14 is a photograph of a load cell with adapters to fit between a receiver and the transducer shaft. This entire assembly increases the effective length of the transducer shaft by 3.0 inches.

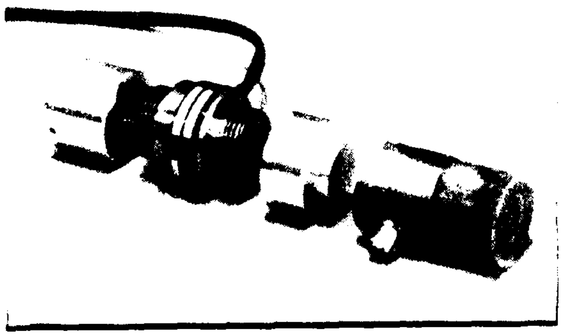

Figure 14. Load cell mounting assembly

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The Hamilton Frame is a velocimeter used aboard the Deep Sea Drilling Project (DSDP) drill ship GLOMAR CHALLENGER, and at the Naval Ocean Systems Center (NOSC), to measure the compressional wave velocity within sediment and rock samples. The design of this instrument has been modified at the Naval Ocean Research and Development Activity (NORDA) to permit both compressional and shear wave velocity measurements. The modified device also monitors the transducer induced stress on the sample material, a factor which is critical to some

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measurement. This report documents, with mechanical drawings and photographs, the mechanical details of the Modified Hamilton Frame in use at NORDA.